3.0 Groundwater Pathway

Results in Brief: 2005 Groundwater Pathway

Groundwater Remedy – In 2005, extraction well operations were impacted by the construction of the converted advanced wastewater treatment facility, site D&D activities, and site soil remediation activities. During these activities, groundwater treatment capacity was, at times limited, resulting in the need to temporarily reduce aquifer remediation operations. In order to ensure worker safety, the entire pump and treat operation had to be shutdown at times for periods up to one week. At the start of 2005, only the South Plume and South Field Modules were operating. The Waste Storage Area Module resumed operations in March 2005 concurrent with the start-up of the converted advanced wastewater treatment facility.

In 2005, a study was completed that tested the feasibility of inducing recharge to the aquifer by pumping clean groundwater to the storm sewer outfall ditch in the South Field area. Groundwater modeling predictions indicate that this will shorten the time required to cleanup the uranium plume in the South Field area. In early 2006, the decision was made to proceed with pumping clean groundwater into the storm sewer outfall ditch as a supplement to natural flow of storm water entering the ditch.

In October 2005, the Groundwater Certification Plan was issued (DOE 2005b). The plan defines a programmatic strategy for certifying completion of the aquifer remedy. It was developed through a series of meetings between the DOE, EPA, and OEPA.

In June 2005, the Waste Storage Area Phase II Design Report was issued. An addendum to the design was issued in December 2005 (DOE 2005g). The design identifies the need for installation of an additional extraction well and associated monitoring wells in the waste storage area. Installation of these wells will complete the aquifer remedy system, which will continue to operate post closure.

In 2005, forty groundwater monitoring wells installed in the Great Miami Aquifer were plugged and abandoned in an effort to facilitate site closure.

Since 1993

- 18,342 million gallons (69,425 million liters) of water have been pumped from the Great Miami Aquifer
- 1,936 million gallons (7,328 million liters) of water have been re-injected into the Great Miami Aquifer
  Note: Well-based re-injection ceased in 2004
- 7,124 net pounds (3,234 kg) of uranium have been removed from the Great Miami Aquifer.

During 2005

- 1,656 million gallons (6,268 million liters) of water were pumped from the Great Miami Aquifer
- 602 pounds (273 kg) of total uranium were removed from the Great Miami Aquifer.

Groundwater Monitoring Results – Uranium concentrations within the footprint of the maximum uranium plume continue to decrease in response to pumping.

- Characterization in the waste storage area was conducted to finalize a design for the Waste Storage Area Phase II Module. Characterization indicated that the manganese plume footprint is larger than the uranium plume footprint. Groundwater modeling predicts that both plumes can be effectively remediated.
- Direct push sampling in the South Plume area shows that uranium concentrations continue to decrease. Except for a small area just south of Willey Road, the off-property uranium plume concentration has dropped to less than 100 µg/L.

On-site Disposal Facility Monitoring – Leak detection monitoring continued in 2005 for Cells 1 through 8. For those constituents monitored to meet on-site disposal facility requirements, there were no exceedances of groundwater FRLs for the Great Miami Aquifer wells. Data collected from the cells indicate that the liner systems are performing well within the specifications outlined in the approved cell design.

This chapter provides background information on the nature and extent of groundwater contamination in the Great Miami Aquifer due to past operations at the Fernald site and summarizes:

- Aquifer restoration progress
- Groundwater monitoring activities and results for 2005.

Restoration of the affected portions of the Great Miami Aquifer and continued protection of the groundwater pathway are primary considerations in the accelerated remediation strategy for the Fernald site. The FCP will continue to monitor the groundwater pathway throughout remediation to ensure the protection of this primary exposure pathway.

3.1 Summary of the Nature and Extent of Groundwater Contamination

Groundwater Modeling at the Fernald Site

The Fernald site uses a computer model to make predictions about how the concentration/location of contaminants in the aquifer will change over time. Because the model contains simplifying assumptions about the aquifer and the contaminants, the predictions about future behavior must be verified with field measurements obtained from groundwater monitoring activities.

If groundwater monitoring data indicate the need for operational changes to the groundwater remedy, the groundwater model is run to predict the effect those changes might have on the aquifer and the contaminants. If the predictions indicate the proposed changes would increase cleanup efficiency and reduce the cleanup time and cost, the operational changes are made and monitoring data are collected after the changes to verify whether model predictions were correct. If model predictions prove to be incorrect, modifications are made to the model to improve its predictive capabilities.

The nature and extent of groundwater contamination from operations at the Fernald site have been investigated and the risk to human health and the environment from those contaminants has been evaluated in the Operable Unit 5 Remedial Investigation Report. As documented in that report, the primary groundwater contaminant at the site is uranium.

Groundwater contamination resulted from infiltration of contaminated surface water through the bed of Paddys Run, the storm sewer outfall ditch, the Pilot Plant drainage ditch, and the waste storage area ditch (previously located between the Plant-1 Pad and Paddy's Run). In these areas, the glacial overburden is eroded, creating a direct pathway between surface water and the sand and gravel of the aquifer. To a lesser degree, groundwater contamination also resulted where past excavations (such as the waste pits) removed some of the protective clay contained in the glacial overburden and exposed the aquifer to contamination.

3.2 Selection and Design of the Groundwater Remedy

While a remedial investigation and feasibility study was in progress and a groundwater remedy was being selected, off-property contaminated groundwater was being pumped from the South Plume area by the South Plume Removal Action System (referred to as the South Plume Module). In 1993, this system was installed south of Willey Road and east of Paddys Run Road to stop the uranium plume in this area from migrating any farther to the south. Figure 3-1 shows the South Plume Module Extraction Wells 3924, 3925, 3926, and 3927. These extraction wells have successfully stopped further southern migration of the uranium plume beyond the wells and have contributed to significantly reducing total uranium concentrations in the off-property portion of the plume.

After the nature and extent of groundwater contamination were defined in the Operable Unit 5 Remedial Investigation Report, various remediation technologies were evaluated in the Feasibility Study Report for Operable Unit 5. Remediation cost, efficiency, and various land-use scenarios were considered during the development of the preferred remedy for restoring the quality of the groundwater in the aquifer. The Operable Unit 5 Feasibility Study Report recommended a concentration-based, pump-and-treat remedy for the groundwater contaminated with uranium, consisting of 28 groundwater extraction wells located on and off property. Computer modeling suggested that the 28 extraction wells pumping at a combined rate of 4,000 gallons per minute (gpm) (15,140 liters per minute [Lpm]) would remediate the aquifer within 27 years.

The recommended groundwater remedy was presented to EPA, OEPA, and stakeholders in the Proposed Plan for Operable Unit 5 as the Preferred Groundwater Remedy (DOE 1995c). Once the Proposed Plan was approved, the Operable Unit 5 Record of Decision was presented to stakeholders and subsequently approved by EPA and OEPA in January 1996. The Operable Unit 5 Record of Decision formally defines the selected groundwater remedy and establishes FRLs for all constituents of concern.

Re-injection at the Fernald Site

From 1998 to 2004, re-injection was an enhancement to the groundwater remedy at the Fernald site, supplementing pump-and-treat operations. The term "well-based" refers to the injection of treated groundwater through specially designed re-injection wells. Groundwater pumped from the aquifer was treated to remove contaminants and then re-injected into the aquifer at strategic well locations. Because the treatment process was not 100 percent efficient, a small amount of uranium is re-injected into the aquifer with the treated water. The re-injected groundwater increased the speed at which dissolved contaminants moved through the aquifer and were pulled by extraction wells, thereby decreasing the overall remediation time. Based on updated groundwater modeling and the unfavorable results of a cost/benefit analysis, well-based re-injection was discontinued in 2004.

The Operable Unit 5 Record of Decision commits to an ongoing evaluation of innovative remediation technologies so that remedy performance can be improved as such technologies become available. As a result of this commitment, an enhanced groundwater remedy was presented in the Operable Unit 5 Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1) (DOE 1997a). Groundwater modeling studies conducted in order to design the enhanced groundwater remedy suggested that, with the early installation of additional extraction wells and the use of re-injection technology, the remedy could potentially be reduced to 10 years. EPA and OEPA approved the enhanced groundwater remedy that relies on pump-and-treat and re-injection technology. The groundwater remedy included the use of well-based re-injection up until September 2004.

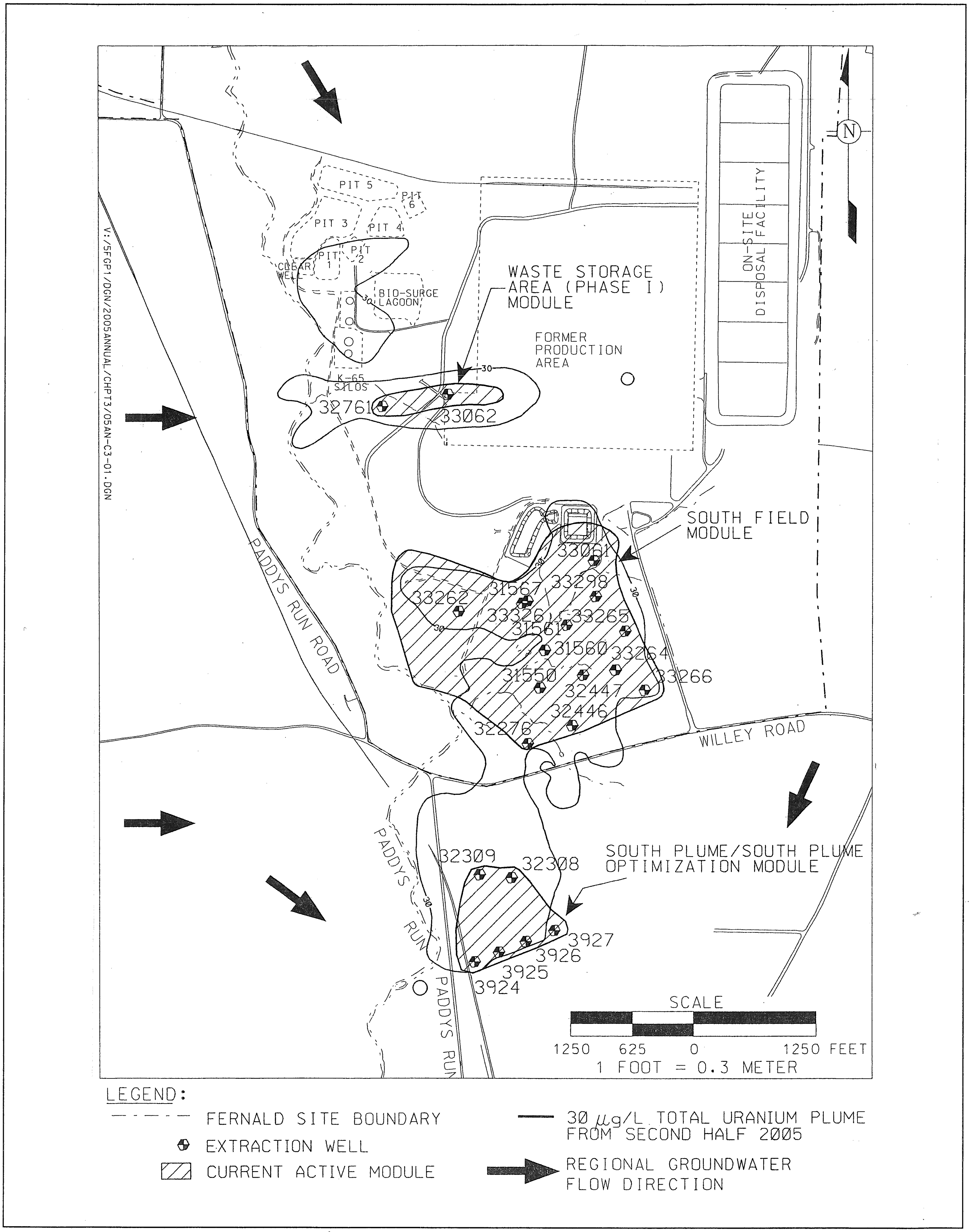

Figure 3-1. Extraction Wells Active in 2005

Evolution of the enhanced groundwater remedy has been documented through a series of approved designs. These remedies are: The Operable Unit 5 Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1), Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas (DOE 2001a), Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module (DOE 2002a), Comprehensive Groundwater Strategy Report (DOE 2003a), and the Groundwater Remedy Evaluation and Field Verification Plan (DOE 2004).

The enhanced groundwater remedy commenced in 1998 with the start-up of the South Field (Phase I), South Plume Optimization, and Re-injection Demonstration Modules. It focuses primarily on the removal of uranium, but has also been designed to limit the further expansion of the plume, achieve removal of all targeted contaminants to concentrations below designated FRLs, and prevent undesirable groundwater drawdown impacts beyond the site's boundary. Start-up of the enhanced groundwater remedy included a year-long re-injection demonstration that was initiated in September 1998. Through the years, additional extraction and re-injection wells have been added to these initial restoration modules.

In 2001, the EPA and OEPA approved the Design for Remediation of the Great Miami Aquifer in the waste storage and Plant 6 areas. Approval of this design initiated the installation of the next planned aquifer restoration module. The design specified three extraction wells in the waste storage area to address contamination in the Pilot Plant drainage ditch plume (Phase I) and two extraction wells to address the remaining contamination after the waste pit excavation is completed (Phase II). One of the three Phase I waste storage area wells was installed in 2000 to support an aquifer pumping test to help determine the restoration well field design. The remaining two Phase I wells were installed in the summer of 2001 after the design was approved by EPA and OEPA. All three wells became operational on May 8, 2002. One was abandoned in 2004 in order to facilitate site remediation work. A replacement well is scheduled to begin operating in 2006.

The Design for Remediation of the Great Miami Aquifer in the waste storage and Plant 6 areas also provided data indicating that the uranium plume in the Plant 6 area was no longer present. It was believed that the uranium plume had dissipated to concentrations below the FRL as a result of the shut-down of plant operations in the late 1980s and the pumping of highly contaminated perched water as part of the Perched Water Removal Action #1 in the early 1990s. Because a uranium plume with concentrations above the groundwater FRL was no longer present in the Plant 6 area at the time of the design, a restoration module for the area was determined to be unnecessary. Groundwater monitoring continued in the Plant 6 area with one well in the area having sporadic total uranium FRL exceedances.

In 2002, the EPA and OEPA approved the next planned groundwater restoration design document, the Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module. The Phase II design presents an updated interpretation of the uranium plume in the South Field area along with recommendations on how to proceed with remediation in the area, based on the updated plume interpretation. Installation of Phase II components was initiated in 2002. The overall system (Phases I and II) is referred to as the South Field Module.

In 2003, groundwater remediation approaches were evaluated to determine the most cost-effective groundwater remedy infrastructure, including the wastewater treatment facility, to remain after site closure. An evaluation of alternatives was presented in the Comprehensive Groundwater Strategy Report. In October 2003, initial discussions were held with the regulators and the public concerning the various alternatives identified in the report. These discussions culminated in an identified path forward to work collaboratively with the Fernald Citizens Advisory Board, EPA, and OEPA to determine the most appropriate course of action for the ongoing aquifer restoration and water treatment activities at the Fernald site.

In 2004, a decision regarding the future aquifer restoration and wastewater treatment approach was made following regulatory and public input. In May, EPA and OEPA approved the decision to reduce the size of the advanced wastewater treatment facility; in June, they approved the decision to discontinue the use of well-based re-injection. Reducing the size of the advanced wastewater treatment facility provides the opportunity to dismantle and dispose of approximately 90 percent of the existing facility in the on-site disposal facility in time to meet the 2006 closure schedule and results in a protective, more cost-effective, long-term water treatment facility to complete aquifer restoration. Well-based re-injection was discontinued based upon groundwater modeling cleanup predictions presented in the Comprehensive Groundwater Strategy Report and the Groundwater Remedy Evaluation and Field Verification Plan. The updated modeling indicated that the aquifer restoration time frame would likely be extended beyond dates previously predicted in part due to refined modeling input. The updated modeling also indicated that continued use of the groundwater re-injection wells would shorten the aquifer remedy by approximately three years. Therefore, the benefit of continuing re-injection did not justify the cost. Well-based re-injection was discontinued in September 2004 to support construction of the converted advanced wastewater treatment facility. All re-injection wells are remaining in place as potential points for the groundwater remedy performance monitoring. Since operations will proceed without well-based re-injection, other operational strategies to enhance the aquifer remedy are being explored (e.g., inducing infiltration to the Great Miami Aquifer through the storm sewer outfall ditch).

In 2005, the Waste Storage Area Phase II Design Report was issued. Comments received from EPA and OEPA resulted in the issuance of an addendum to the report in December 2005. EPA approved the design; however OEPA approval is still pending. The design identifies the need for installation of one more extraction well in the waste storage area, near the former silos area. This will bring the total number of extraction wells in the Waste Storage Area Module up to four completing the aquifer remedy system to remain in operation post closure. Pending OEPA approval, the additional extraction well will become operational in 2006.

In 2005, an infiltration test was conducted in the storm sewer outfall ditch. The test consisted of gauging the flow into and out of the storm sewer outfall ditch with six Parshall flumes. This was done so the overall infiltration along the storm sewer outfall ditch could be obtained. Findings from the test were included in the Storm Sewer Outfall Ditch Infiltration Test Report (DOE 2005f). The decision was made that natural storm water flow into the storm sewer outfall ditch will be supplemented with pumped clean groundwater. Three existing construction wells on the east side of the Fernald site will be used to deliver as much clean groundwater as needed to maintain an approximate 500 gpm (1,890 Lpm) flow into the former storm sewer outfall ditch. Supplemental pumping will continue until the existing wells, pumps, or motors are no longer serviceable. At that time the operation will be suspended, pending a determination regarding the benefits to the aquifer remedy. Also, as much surface water runoff as possible will be directed to the former storm sewer outfall ditch. A future source of surface water runoff will include runoff from the former production area following removal of the Storm Water Retention Basin and completion of final site grading. Pumping is planned to begin in 2006. Until pumping begins, the flumes will be maintained in their current configuration and flow measurements into the former storm sewer outfall ditch will continue.

The Fernald Groundwater Certification Plan was issued and approved by EPA in 2005. The certification plan defines a programmatic strategy for certifying completion of the aquifer remedy. It was developed through a series of four technical information exchange meetings held in 2005 between the DOE, EPA, and OEPA. The Fernald Groundwater Certification Plan identifies that the IEMP will continue to be the plan that includes remedy performance monitoring requirements.

In 2005, extraction well operations were impacted by the construction of the converted advanced wastewater treatment facility, site D&D activities, and site soil remediation activities. During these activities, groundwater treatment capacity was, at times limited, resulting in the need to temporarily reduce aquifer remediation operations. In order to ensure worker safety, the entire pump and treat operation had to be shutdown at times for periods up to one week. At the start of 2005, the South Plume and South Field Modules were operating. The Waste Storage Area Module resumed operations in March 2005 concurrent with the start-up of the converted advanced wastewater treatment facility. Figure 3-1 shows the extraction well locations that were active in 2005. The operational information associated with these modules is presented in the following subsections. Figure 3-2 identifies current and future extraction well locations. At the end of 2005, the only remaining planned groundwater remedy module component was an additional extraction well in the waste storage area as defined in the Waste Storage Area Phase II Design Report.

3.3 Groundwater Monitoring Highlights for 2005

For this annual site report, groundwater monitoring results are discussed in terms of restoration and compliance monitoring.

The key elements of the Fernald site groundwater monitoring program design are described below.

- **Sampling** – Sample locations, frequency, and constituents were selected to address operational assessment, restoration assessment, and compliance requirements. Selected wells are monitored for up to 50 groundwater FRL constituents. Monitoring is conducted to ascertain groundwater quality and groundwater flow direction. Figure 3-3 shows a typical groundwater monitoring well at the site and Figure 3-4 identifies the relative placement depths of groundwater monitoring wells at the site.
- As part of the comprehensive groundwater monitoring program specified in the IEMP (Revision 4), approximately 140 wells were monitored for water quality in 2005. Figures 3-5 and 3-6 identify the locations of the current water quality monitoring wells. In addition to water quality monitoring, approximately 170 wells were monitored quarterly for groundwater elevations to determine groundwater flow direction. Figure 3-7 depicts the routine water level (groundwater elevation) monitoring wells, including extraction wells, as specified in the IEMP (Revision 4).
- **Data Evaluation** – The integrated data evaluation process involves review and analysis of the data collected from wells to determine capture and restoration of the uranium plume; capture and restoration of non-uranium FRL constituents; water quality conditions in the aquifer that indicate a need to modify the design and installation of restoration modules; and the impact of ongoing groundwater restoration on the Paddys Run Road Site plume (a separate contaminant plume unrelated to the Fernald site, resulting from industrial activities in the area located south of the Fernald site along Paddys Run Road).
- **Reporting** – All data are reported through the annual site environmental reports

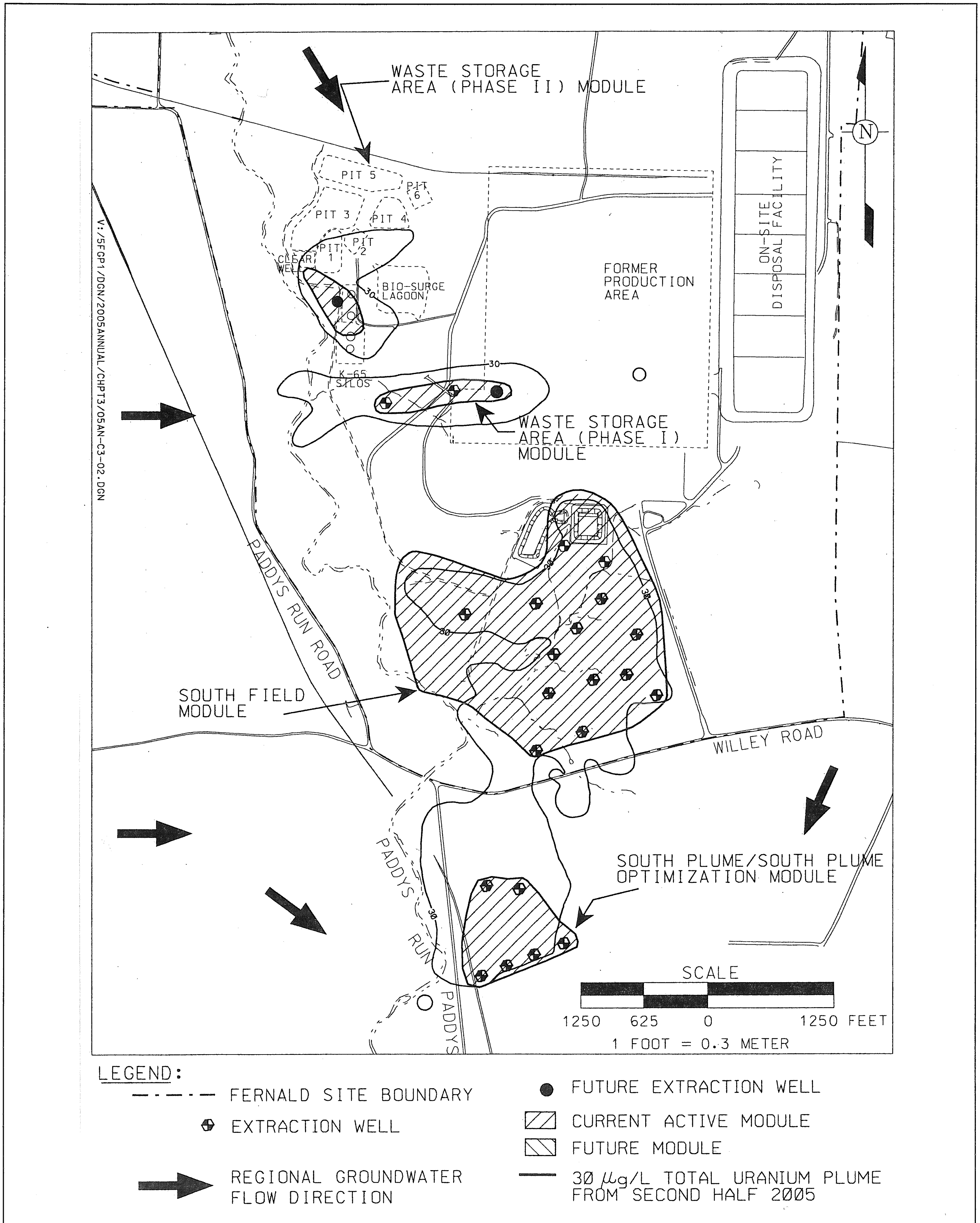

Figure 3-2. Current and Future Extraction Wells for the Groundwater Remedy

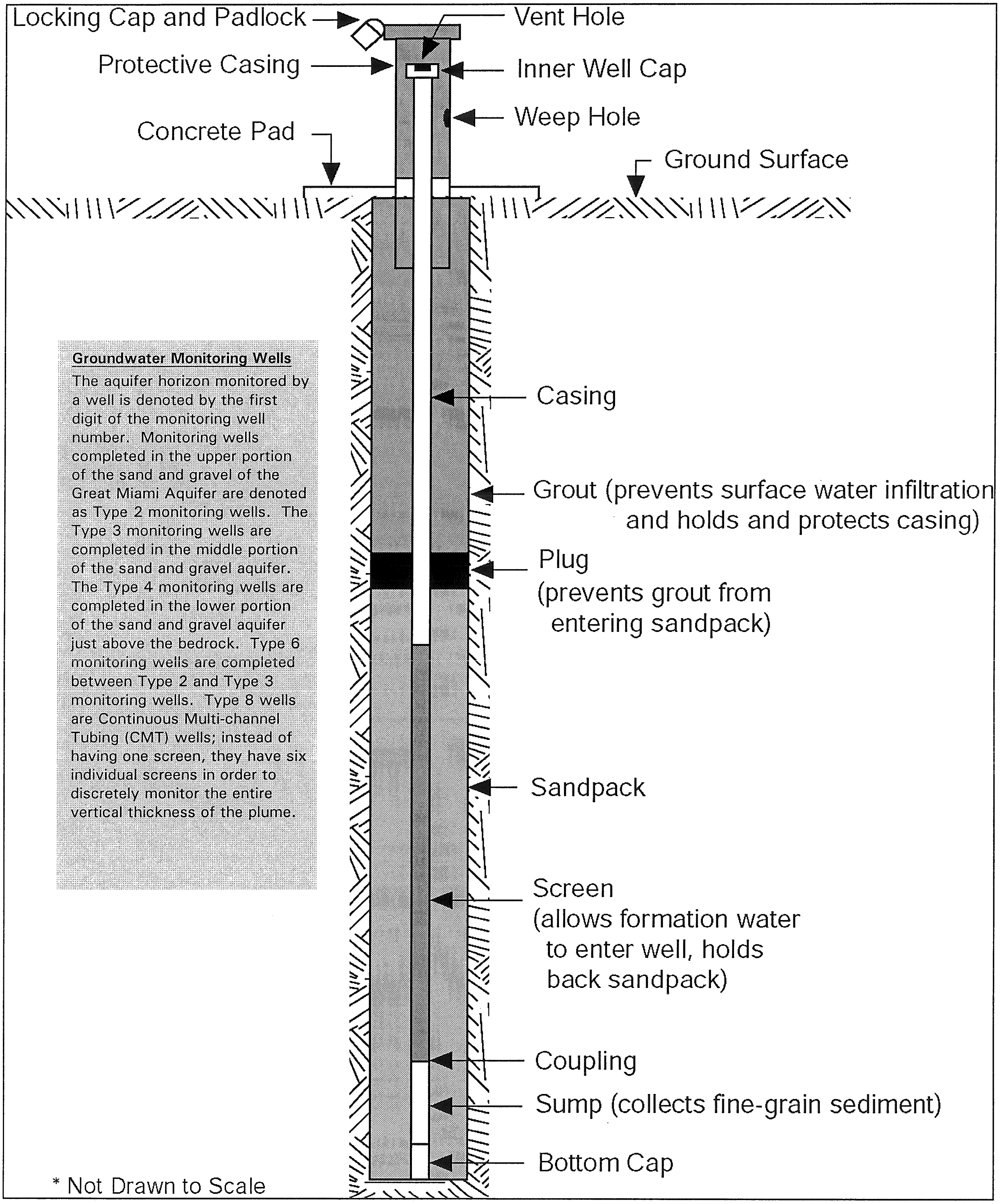

Figure 3-3. Diagram of a Typical Groundwater Monitoring Well

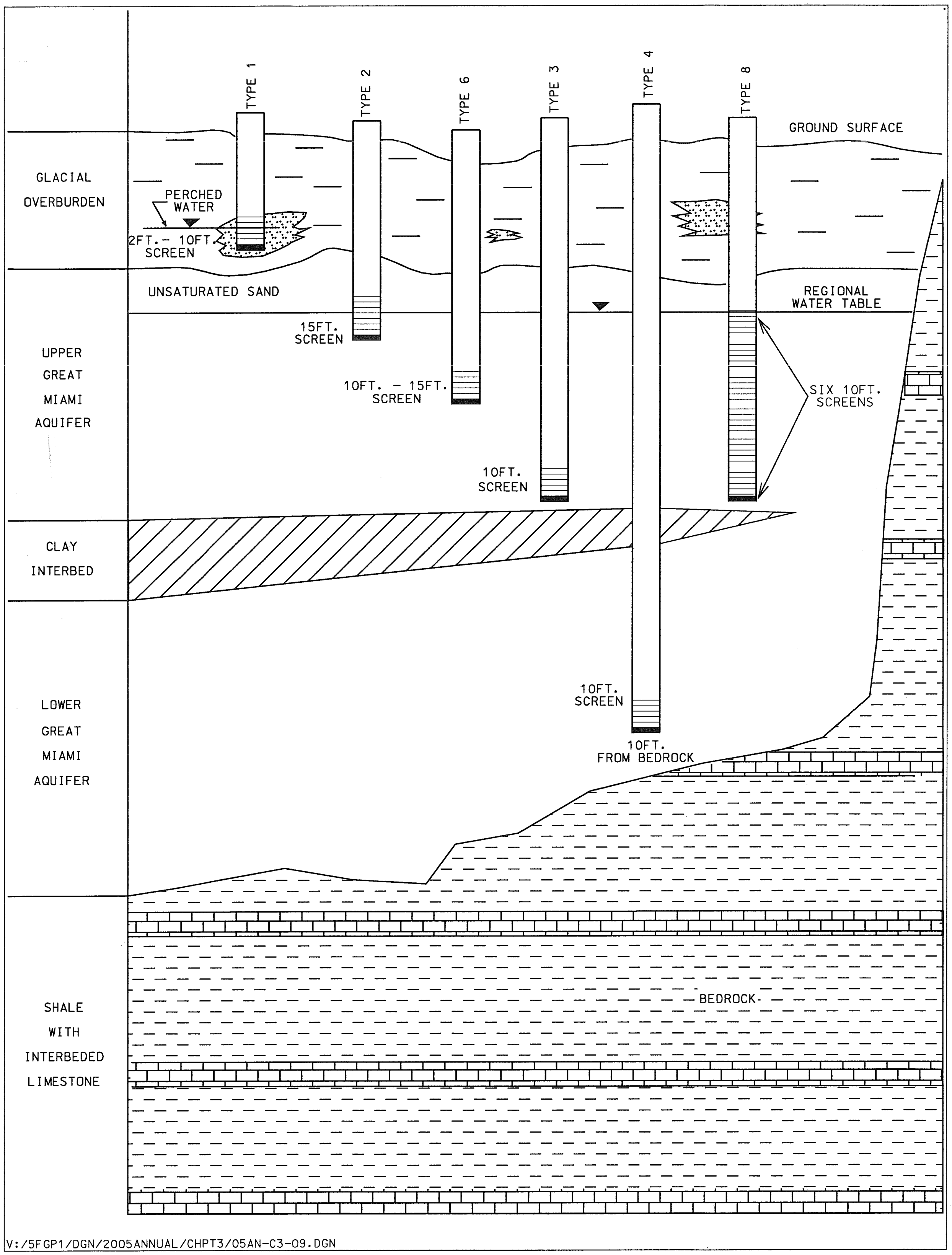

Figure 3-4. Monitoring Well Relative Depths and Screen Locations

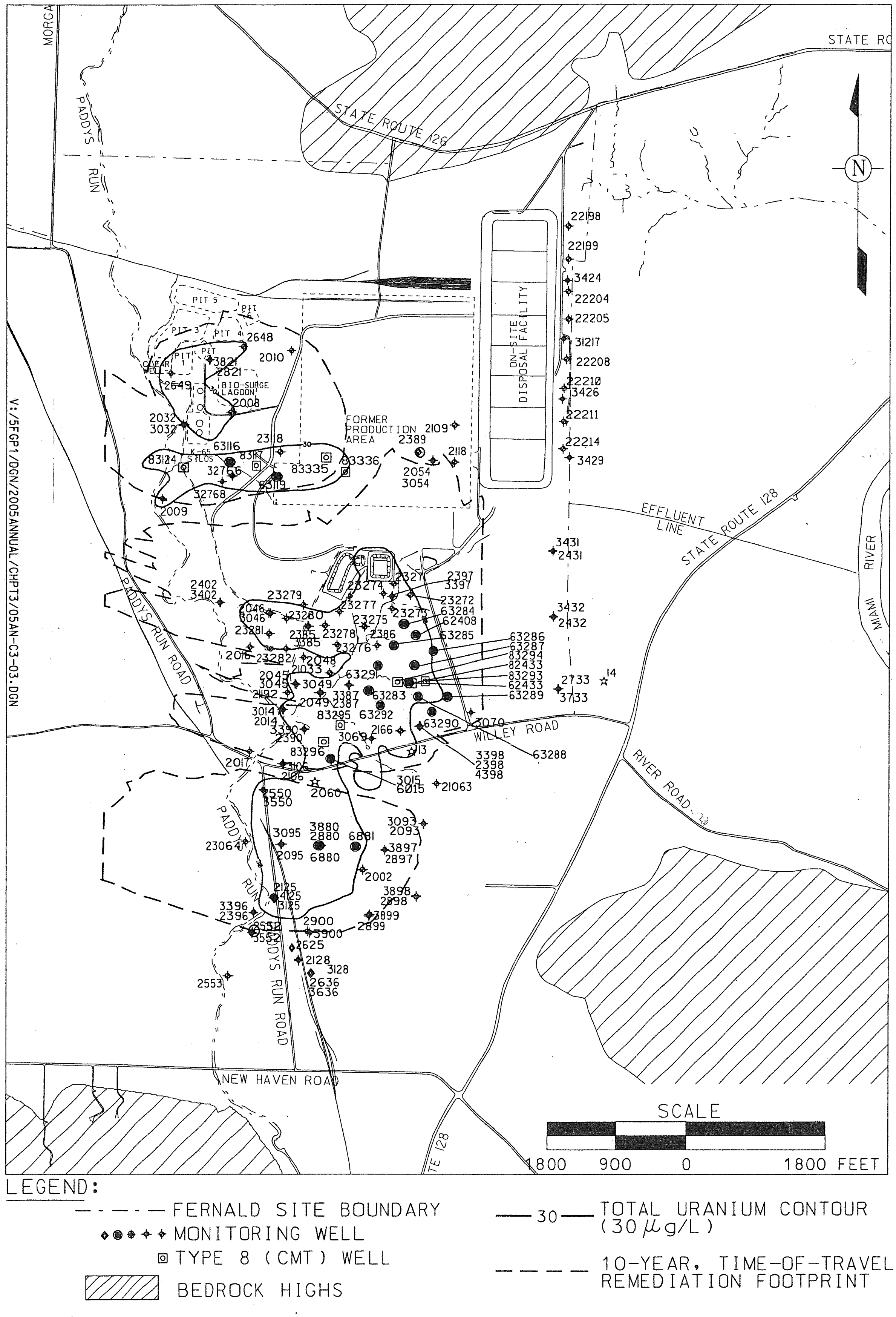

Figure 3-5. Locations for Semiannual Total Uranium Monitoring

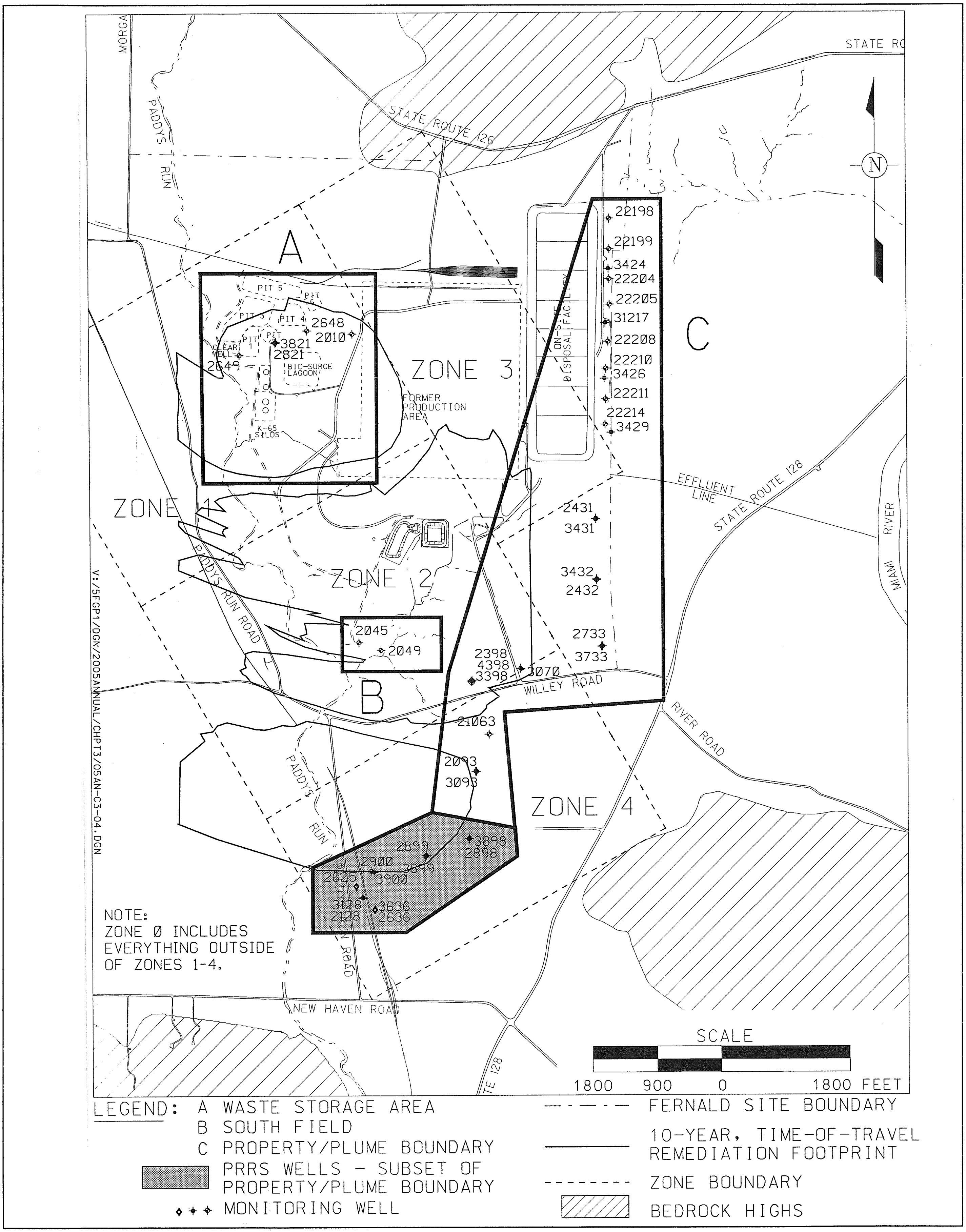

Figure 3-6. Locations for Semiannual Non-uranium Monitoring

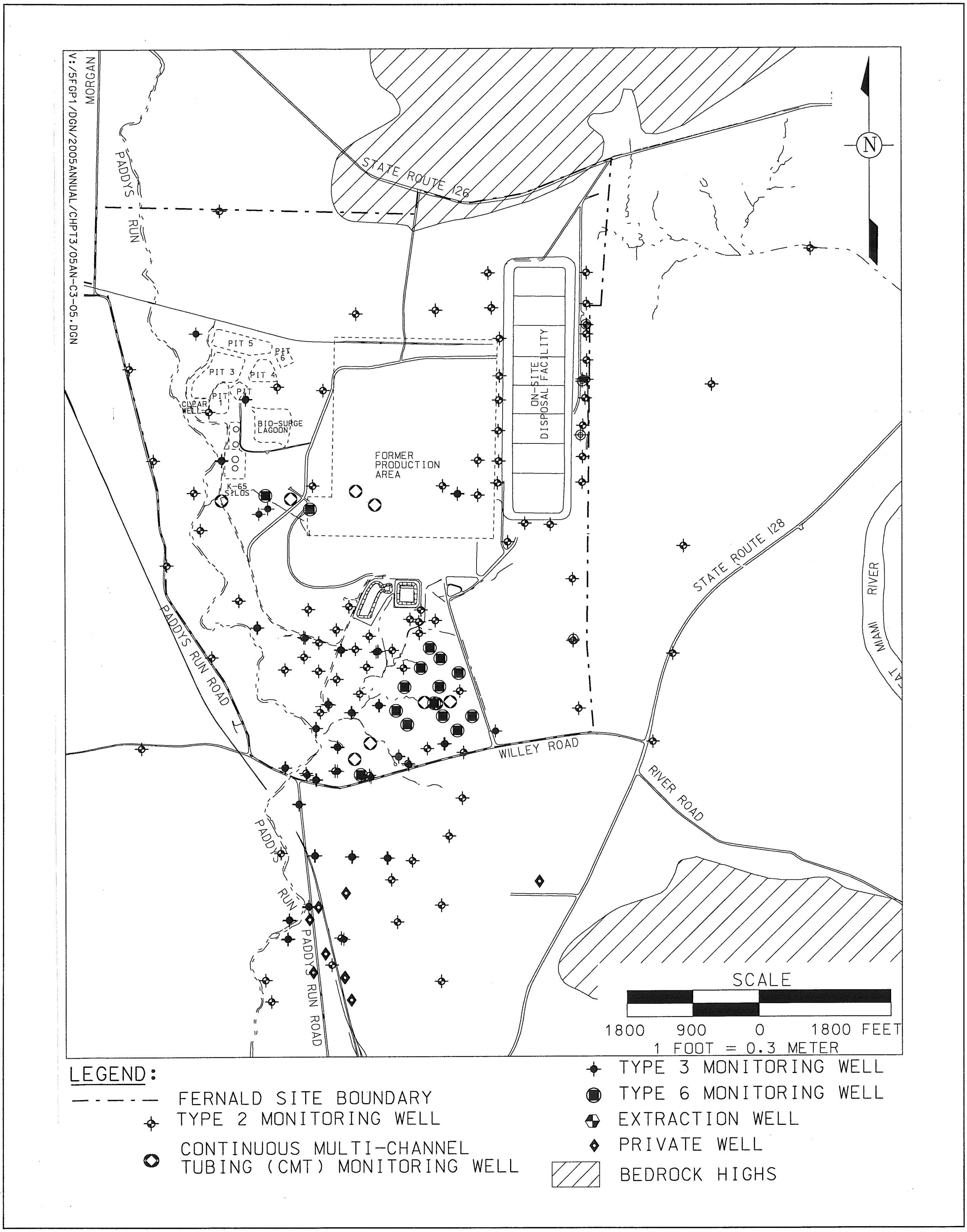

Figure 3-7. IEMP Groundwater Elevation Monitoring Wells

3.3.1 Restoration Monitoring

In general, restoration monitoring tracks the progress of the groundwater remedy and water quality conditions. All operational modules are evaluated during the year to determine the progress of aquifer remediation. Uranium concentration maps are developed from analytical data and compared with groundwater elevation maps depicting the location of capture zones.

More detailed information can be found in Appendix A of this report. Subsections that follow identify the specific attachment of Appendix A where the detailed information can be found.

3.3.1.1 Operational Summary

Figure 3-1 shows the extraction well locations associated with the restoration modules operating in 2005. With the exception of the waste storage area, all wells currently planned for the groundwater remedy have been installed. Table 3-1 summarizes the pounds of uranium removed and the amount of groundwater pumped by the active restoration modules during 2005. Several operational disruptions were necessary during 2005 to facilitate site remediation and construction of the converted advanced wastewater treatment facility. Additional details are provided in the individual module operational summaries provided in Sections 3.3.1.2 through 3.3.1.4. Figure 3-8 identifies the yearly and cumulative pounds of uranium removed from the Great Miami Aquifer from 1993 through 2005.

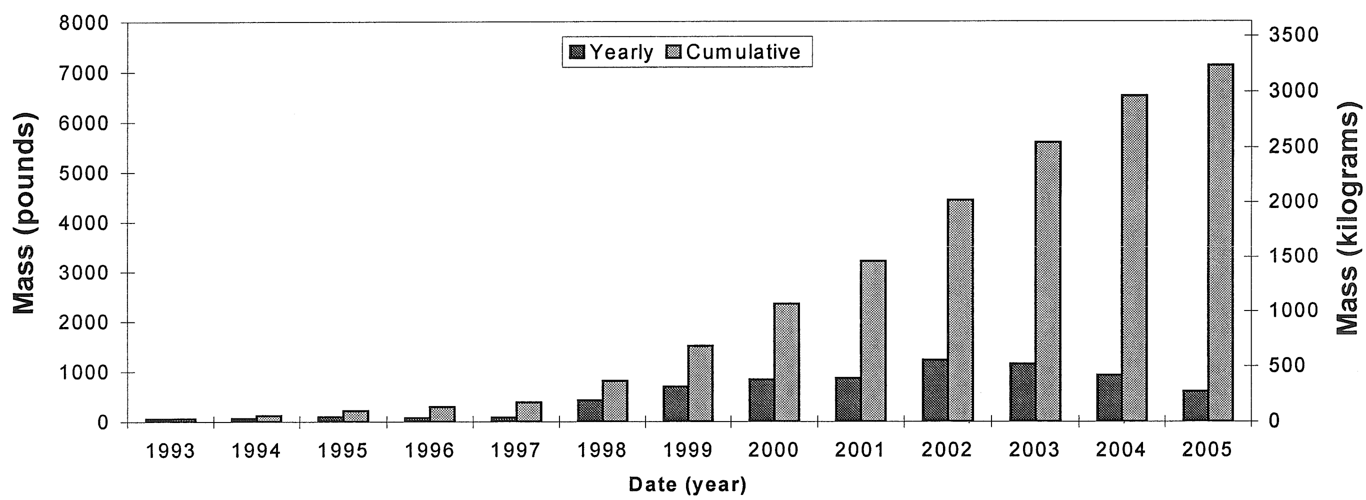

Figure 3-8. Net Pounds of Uranium Removed from the Great Miami Aquifer, 1993-2005

Since 1993:

- 18,342 million gallons (69,425 million liters) of water have been pumped from the Great Miami Aquifer
- 1,936 million gallons (7,328 million liters) of treated water have been re-injected into the Great Miami Aquifer
- 7,124 net pounds (3,234 kg) of total uranium have been removed from the Great Miami Aquifer.

Appendix A, Attachment A.1, of this report provides detailed operational information on each extraction and re-injection well, such as pumping and re-injection rates, uranium removal indices, and total uranium concentration graphs. The following sections provide an overview of the individual modules.

TABLE 3-1
GROUNDWATER RESTORATION MODULE STATUS FOR 2005

Modules & Restoration Wells	Target Pumping 1/1/05 to 3/1/05		Target Pumping 3/1/05 to 12/31/05		Volume Pumped (Millions)		Uranium Removed	
	gpm	Lpm	gpm	Lpm	gallons	liters	lbs	kg
South Plume/ South Plume Optimization Module: 3924, 3925, 3926, 3927, 32308, 32309	1,900	7,192	1,400	5,299	518	1,961	105	48
South Field Module: 31550, 31560, 31561, 31567[a], 32276, 32446, 32447, 33061, 33262, 33264, 33265, 33266, 33298, 33326[a]	2,675	10,125	2,575	9,746	911	3,448	383	174
Waste Storage Area Module[b,c]: 32761, 33062	0	0	700	2,650	227	859	113	51
Aquifer Restoration System Total Pumped	4,575	17,316	4,675	17,695	1,656	6,268	602	273

[a]Extraction Well 31567 began operating in July 1998. Extraction Well 33326 replaced this well in September 2005.
[b]Extraction wells were shut down January 1 to March 1, 2005 to facilitate the converted advanced wastewater treatment facility construction.
[c]Extraction Well 33334 was installed in 2005, but will not become operational until 2006.

3.3.1.2 South Plume/South Plume Optimization Module Operational Summary

The four extraction wells of the South Plume Module (Extraction Wells 3924, 3925, 3926, and 3927) began operating in August 1993. The two extraction wells of the South Plume Optimization Module (Extraction Wells 32308 and 32309) began operating in August 1998. Figure 3-9 illustrates the uranium plume capture observed for the South Plume/South Plume Optimization Module in the fourth quarter of 2005. During 2005, 518 million gallons (1,961 million liters) of groundwater and 105 pounds (48 kg) of uranium were removed from the Great Miami Aquifer by the South Plume/South Plume Optimization Module. Based on analysis of the data collected in 2005, the module continues to meet its primary objectives as demonstrated by the following:

- Southward movement of the uranium plume beyond the southern most extraction wells has not been detected.
- Active remediation of the central portion of the off-property uranium plume continues to reduce plume concentration. Nearly the entire off-property uranium plume concentration is now below 100 µg/L. At the start of pumping in 1993, areas in the off-property uranium plume had concentrations over 300 µg/L.
- Paddys Run Road Site plume, located south of the extraction wells, is not being adversely affected by the pumping.

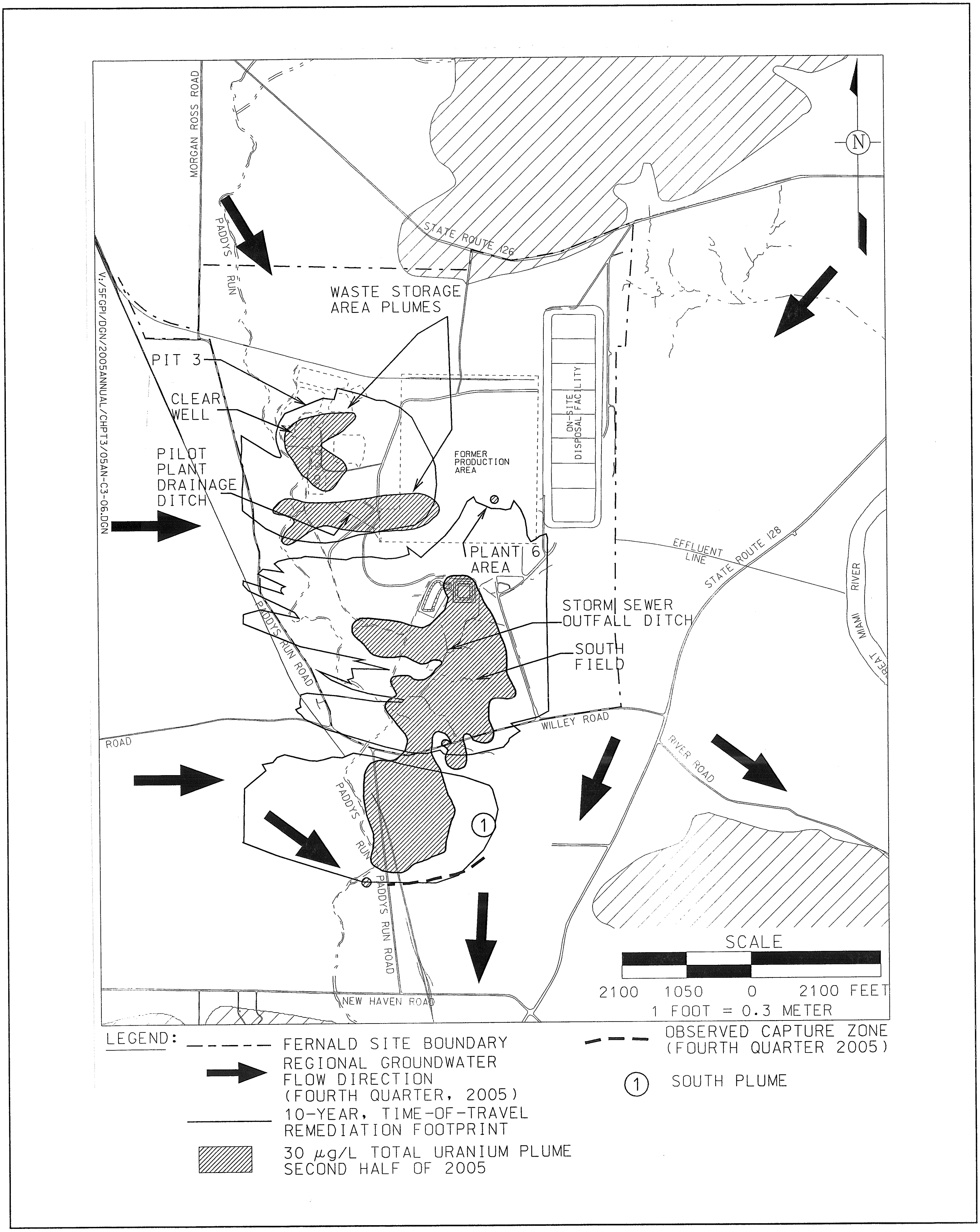

Figure 3-9. Total Uranium Plume in the Aquifer with Concentrations Greater than 30 μg/L at the End of 2005

3.3.1.3 South Field Module Operational Summary

The South Field Module was constructed in two phases. Phase I began operating in July 1998 and Phase II began operating in July 2003. During 2005, fourteen extraction wells were operational.

The 10 original extraction wells installed under Phase I were 31550, 31560, 31561, 31562, 31563, 31564, 31565, 31566, 31567, and 32276. Six of the original 10 wells have been shutdown (31564, 31565, 31566, 31563, 31562, and 31567).

- Extraction Wells 31564 and 31565 were shut down in December 2001 and May 2001, respectively, to accommodate soil remedial activities.
- Extraction Well 31566 was shut down in August 1998 and was replaced by Extraction Well 33262, which was installed as part of South Field (Phase II) Module.
- Extraction Well 31563 was shut down in December 2002 and converted to a re-injection well that began operating in 2003.
- Extraction Well 31562 was shut down in March 2003 and replaced by Extraction Well 33298.
- Extraction Well 31567 was shut down in September of 2005 and replaced by Extraction Well 33326.

Three new extraction wells (Extraction Wells 32446, 32447, and 33061) were added to the South Field Module between 1998 and 2002. These three new extraction wells were installed in the eastern, downgradient portion of the South Field plume, at locations where total uranium concentrations were considerably above the FRL. Two of these three wells (Extraction Wells 32446 and 32447) were installed in late 1999 and began pumping in February 2000. The third (Extraction Well 33061) was installed in 2001 and became operational in 2002.

Phase II components of the South Field Module are described in the Design for Remediation of the Great Miami Aquifer, South Field (Phase II) Module, which was issued in May 2002. The design provides an updated characterization of the uranium plume in the Great Miami Aquifer beneath the southern portion of the Fernald site and a modeled design for the South Field Module located in that area. All Phase II design components became operational in 2003. The components include:

- Four additional extraction wells, one in the Southern Waste Units area (Extraction Well 33262) and three along the eastern edge of the on-property portion of the southern uranium plume (Extraction Wells 33264, 33265, and 33266).
- One additional re-injection well in the Southern Waste Units area (Re-injection Well 33263).
- A converted extraction well (Extraction Well 31563), which was converted into a re-injection well.
- An injection pond, which is located in the western portion of the Southern Waste Units excavations.

South Field Module re-injection components were shut down in September 2004.

During 2005, 911 million gallons (3,448 million liters) of groundwater and 383 pounds (174 kg) of uranium were removed from the Great Miami Aquifer by the South Field Module.

3.3.1.4 Waste Storage Area (Phase I) Module Operational Summary

The Waste Storage Area Module became operational on May 8, 2002, nearly 17 months ahead of the start date of October 1, 2003 established in the Operable Unit 5 Remedial Action Work Plan. The module consisted of three extraction wells (32761, 33062, and 33063). These three wells were installed to remediate a uranium plume in the Pilot Plant drainage ditch area, according to the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas. In July 2004, Extraction Well 33063 was plugged and abandoned to make way for surface excavation activities. Additionally, Monitoring Wells 83120, 83123, 63121, and 63122 were also plugged and abandoned in 2004 to make way for remedial excavation activities. The remaining two extraction wells in the Waste Storage Area Module were shut down at the end of September 2004 for preventative maintenance and from October 2004 through March 2005 to facilitate construction of the converted advanced wastewater treatment facility. A replacement well for Extraction Well 33063 was installed in 2005 (Extraction Well 33334) and is scheduled to be operational in 2006. Additional monitoring wells were installed in 2005 to replace those that were plugged and abandoned. The final extraction well in the waste storage (Extraction Well 33330) will be installed and become operation in 2006. During 2005, 227 million gallons (859 million liters) and 113 pounds (51 kg) of uranium were removed from the Great Miami Aquifer by the Waste Storage Area Module.

> The 10-year, time-of-travel remediation footprint is an updated model prediction. It illustrates how far a particle of water will travel in response to pumping over a 10-year time period using current pumping locations and target pumping rates for 2003. It replaces the 10-year, uranium-based restoration footprint that was prepared several years ago based on previous model predictions using previous pumping locations and rates that are no longer relevant.

3.3.1.5 Monitoring Results for Total Uranium

Total uranium is the primary FRL constituent because it is the most prevalent site contaminant and has impacted the largest area of the aquifer. Figure 3-9 shows general groundwater flow directions observed during the fourth quarter of 2005 and the interpretation of the uranium plume in the aquifer updated through the second half of 2005. The shaded areas represent the interpreted size of the maximum uranium plume that is above the 30-µg/L groundwater FRL for total uranium. At the end of 2005, approximately 196 acres (79 hectares) of the Great Miami Aquifer were contaminated above the 30-µg/L groundwater FRL for total uranium. The same amount of acreage was identified as being contaminated at the end of 2004. Capture zones observed during the fourth quarter of 2005 for the active restoration modules are also identified in Figure 3-9. These capture zones indicate that the South Plume is being captured by the existing system and that further movement of uranium to the south of the extraction wells is being prevented. Figure 3-9 also depicts the 10-year, time-of-travel remediation footprint that was predicted using 2003 target pumping rates and no well-based re-injection.

Geoprobe® (Direct-Push Sampling)

The Geoprobe®, a hydraulically powered, direct-push sampling tool, is used at the Fernald site to obtain groundwater samples at specific intervals without installing a permanent monitoring well. Direct-push means that the tool employs the weight of the vehicle it is mounted on and percussive force to push into the ground without drilling (or cutting) to displace soil in the tool's path. The Fernald site uses this technique to collect data on the progress of aquifer restoration and to determine the optimal location and depth of additional monitoring and extraction wells that may be installed in the future.

Waste Storage Area – In 2005 the footprint of the maximum uranium plume in the waste storage area was revised to incorporate new data collected from existing monitoring wells and from direct-push sampling locations, sampled as part of the predesign effort in support of the Waste Storage Area Phase II Module design. The new outline of the 30-µg/L uranium plume is shown in Figure 3-9. A design for the Waste Storage Area Phase II Module was issued in June of 2005. An addendum to the design was issued in December 2005 to address EPA and OEPA comments.

Plant 6 Area – The decision not to install an extraction well in the Plant 6 module was made in the Design for Remediation of the Great Miami Aquifer in the waste storage and Plant 6 areas. Monitoring the aquifer in the Plant 6 area continues. As a follow-up to the excavation work completed in the Plant 6 area in 2004, direct-push groundwater samples were collected to determine if conditions had changed. Collected water samples were analyzed for uranium and technetium-99. The objective was to re-evaluate the need to install an extraction well prior to site closure in 2006. Each direct-push sampling location was sampled at different depths below the water table in order to obtain a depth/concentration profile. The direct-push data reinforced the 2001 decision by indicating that no additional extraction wells were needed. However, groundwater monitoring results in the second half of 2004 and first half of 2005 showed FRL exceedances for uranium at Monitoring Well 2389. The uranium concentration decreased to approximately 30 µg/L in the groundwater sample collected during the second half of 2005. Monitoring Well 2389 has had a history of sporadic uranium FRL exceedances. It appears that a thin layer of uranium contamination is present in the upper foot of the aquifer at this location. There is not enough contamination to require the installation of a groundwater extraction well, but groundwater monitoring in the area is warranted and will continue.

South Field and South Plume Areas – Data collected in 2005 indicate that uranium concentrations continue to decrease in the South Field and South Plume areas in response to remediation activities. Additional direct push sampling conducted in 2005 south of Willey Road indicates that with the exception of a small area just south of Willey Road, uranium concentrations within the off-property uranium plume are below 100 µg/L.

Appendix A, Attachment A.2, provides individual monitoring well total uranium results and detailed uranium plume maps for 2005. Appendix A, Attachment A.3, provides quarterly groundwater elevation maps and capture zone interpretations, along with graphical displays of groundwater elevation data.

3.3.1.6 Monitoring Results for Non-uranium Constituents

Although the groundwater remedy is primarily targeting remediation of the uranium plume, other FRL constituents contained within the uranium plume are also being monitored. Figure 3-10 identifies the locations of the wells and direct-push sampling locations (i.e., Geoprobe®) that had non-uranium FRL exceedances. Table 3-2 shows the number of wells exceeding FRLs in 2005; the number of wells exceeding FRLs outside the 10-year, time-of-travel remediation footprint; the groundwater FRLs; and the range of 2005 data inside or outside the 10-year, time-of-travel remediation footprint. Note the direct-push sampling location data were provided in the Waste Storage Area Phase II Design Report and historical and current waste storage area exceedances were factored into the design of the Waste Storage Area Phase II Module.

TABLE 3-2
NON-URANIUM CONSTITUENTS WITH RESULTS ABOVE FINAL REMEDIATION LEVELS DURING 2005

Constituent	Number of Wells Exceeding the FRL	Number of Wells Exceeding the FRL Outside the 10-Year, Time-of-Travel Remediation Footprint	Groundwater FRL	Range of 2005 Data Inside the 10-Year, Time-of-Travel Remediation Footprint[a]	Range of 2005 Data Outside the 10-Year, Time-of-Travel Remediation Footprint[a]
General Chemistry			**(mg/L)**	**(mg/L)**	**(mg/L)**
Nitrate/Nitrite	3	0	11[b]	11.6 to 47.5	NA
Inorganics					
Antimony	1	1	0.0060	NA	0.007
Manganese	5	2	0.90	1.14 to 5.72	1.10 to 3.01
Molybdenum	1	0	0.10	0.524 to 0.687	NA
Zinc	2	2	0.021	NA	0.0228 to 0.0306
Volatile Organics			(µg/L)	(µg/L)	(µg/L)
Trichloroethene	1	0	5.0	68.6 to 82.2	NA
Radionuclides			**(pCi/L)**	**(pCi/L)**	**(pCi/L)**
Technetium-99	2	0	94	140 to 849	NA

[a]NA = not applicable
[b]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4; however, the sampling results are for nitrate/nitrite.

During 2005, non-uranium FRL exceedances were observed at 10 monitoring well locations as shown in Figure 3-10. A total of seven non-uranium FRL constituents exceeded FRLs in monitoring wells in 2005. Additionally, there were 15 direct-push sampling locations in the waste storage area that had non-uranium FRL exceedances during 2005. These locations and exceedances are shown in Figure 3-10. Nickel was the only additional constituent (beyond the seven constituents exceeding FRLs in monitoring wells) that had an exceedance at a direct-push sampling location. Nickel is and will continue to be monitored semiannually in the waste storage area.

The exceedance locations along the eastern Fernald site boundary and in the South Plume area are outside the 10-year, time-of-travel remediation footprint. No plumes for the non-uranium above-FRL constituents at the locations outside the 10-year, time-of-travel remediation footprint were identified in the extensive groundwater characterization efforts evaluated as part of the Remedial Investigation Report for Operable Unit 5.

The non-uranium constituents with FRL exceedances at the well locations outside the 10-year, time-of-travel remediation footprint were further evaluated to determine whether they were random events or if they were persistent according to criteria discussed in Appendix A, Attachment A.4. One of the exceedances in 2005 is classified as persistent (manganese at Monitoring Well 22204). In past years, exceedances identified as persistent became non-persistent in later years. Continued monitoring will occur to determine if additional actions are warranted beyond the current aquifer remedy design.

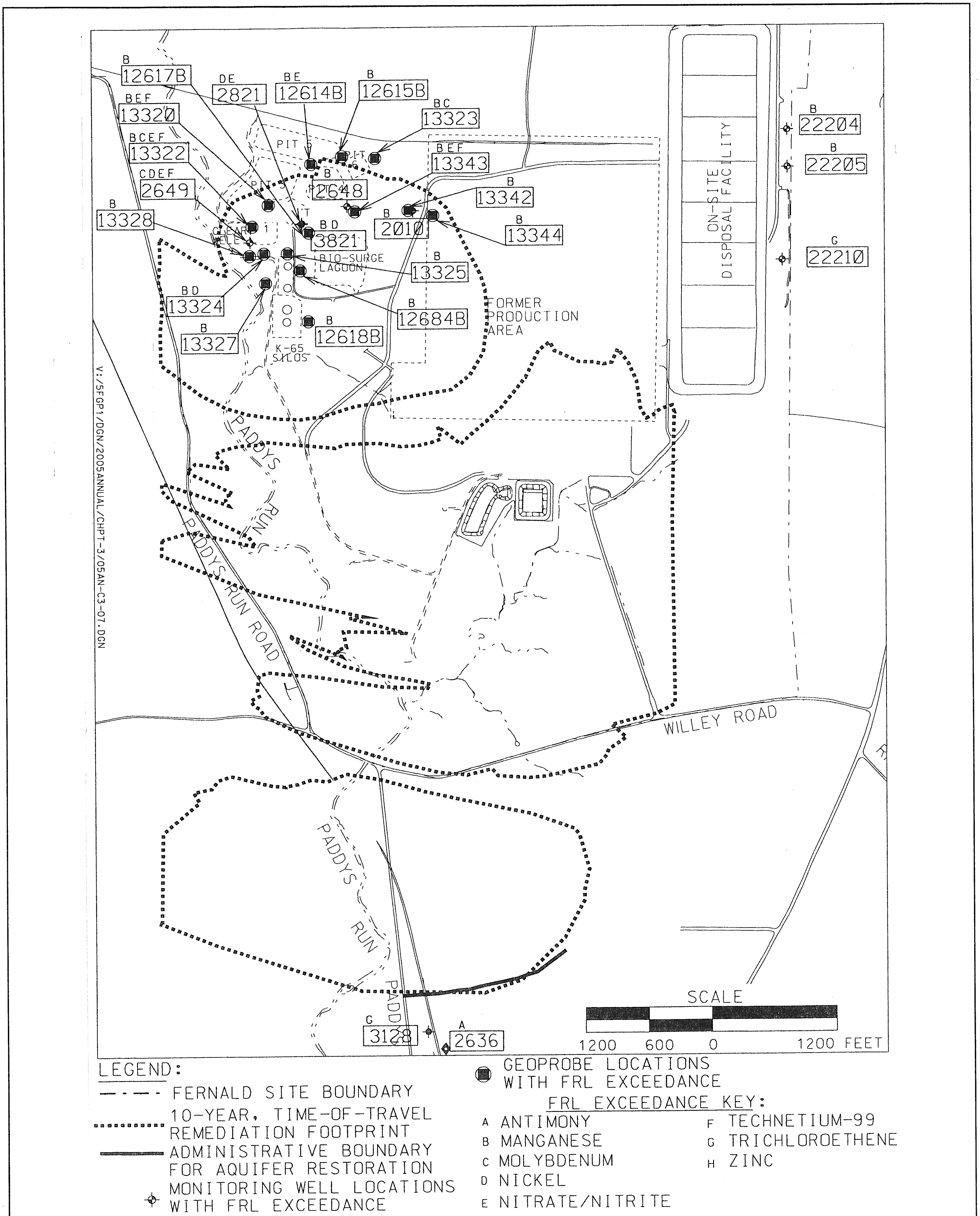

Figure 3-10. Non-Uranium Constituents with 2005 Results Above Final Remediation Levels

3.3.2 Other Monitoring Commitments

Two other groundwater monitoring activities are included in the IEMP: private well monitoring and property boundary monitoring.

As stated earlier, the groundwater data from these activities, along with the data from all other IEMP groundwater monitoring activities, are collectively evaluated for total uranium and, where necessary, non-uranium constituents of concern. The discussion that follows provides additional details on the two compliance monitoring activities.

The three private wells (Monitoring Wells 2060 [12], 13, and 14) located along Willey Road are monitored under the IEMP to assist in the evaluation of the uranium plume migration (for well locations, refer to Figure 2-2 in Chapter 2). It was at one of these private wells that off-property groundwater contamination was initially detected in 1981. Monitoring stopped at the other private wells in 1997 because a DOE-sponsored public water supply became available to Fernald site neighbors who were affected by off-property groundwater contamination.

The availability of the public water supply resulted in the discontinuation of monitoring at many private wells in the affected off-property areas where groundwater is being remediated. Data from the three private wells sampled under the IEMP were incorporated into the uranium plume map shown in Figure 3-9.

During 2005, Property/Plume Boundary Monitoring was comprised of 36 monitoring wells located downgradient of the Fernald site, along the eastern and southern portions of the property boundary. Twenty-five wells were monitored along the eastern Fernald site boundary and slightly downgradient of the South Plume to determine if any contaminant excursions were occurring. Eleven Type 2 and 3 wells were sampled in the Paddys Run Road Site area to document the influence, or lack thereof, that pumping in the South Plume was having on the Paddys Run Road Site Plume. Data from the property/plume boundary wells were integrated with other groundwater data for 2005 and were incorporated into the uranium plume maps shown in Figure 3-9 and in Attachment A.2. Non-uranium data from these wells were included in Section 3.3.1.6.

As indicated in Chapter 2, the Director's Findings and Orders were issued by OEPA on September 7, 2000. These orders specify that the site's groundwater monitoring activities will be implemented in accordance with the IEMP. The revised language allows modification of the groundwater monitoring program as necessary, via the IEMP revision process (subject to OEPA approval), without issuance of a new Director's Order. As determined by OEPA, the IEMP will remain in effect throughout the remedial actions.

3.4 On-site Disposal Facility Monitoring

Groundwater monitoring for the cells of the on-site disposal facility is conducted in the glacial till (perched water) and in the Great Miami Aquifer. Groundwater monitoring in support of the on-site disposal facility continued in 2005. This monitoring program is designed to accomplish the following:

- Establish a baseline of groundwater conditions in both the perched groundwater and the Great Miami Aquifer beneath each cell of the on-site disposal facility. The baseline data will be used to evaluate future changes in perched groundwater and Great Miami Aquifer groundwater quality to help determine if the changes are due to on-site disposal facility operations.

- Continue routine groundwater sampling following waste placement and cell capping as part of the comprehensive leak detection monitoring program for the on-site disposal facility. This information will be used to help verify the ongoing performance and integrity of the on-site disposal facility.

Table 3-3 summarizes the groundwater, leachate collection system, and leak detection system monitoring information associated with the on-site disposal facility. Table 3-3 provides information for Cells 1 through 8 along with sample information and range of total uranium concentrations.

In 2005, monitoring continued for Cells 1 through 8. During 2005, no constituents sampled to meet on-site disposal facility monitoring requirements exceeded groundwater FRLs. However, two non-uranium constituents (manganese and zinc), which are sampled to meet IEMP requirements, exceeded groundwater FRLs at Monitoring Well 22204 (manganese), Monitoring Well 22205 (manganese), and Monitoring Well 22210 (zinc), as identified in Section 3.3.1.6.

The final anticipated on-site disposal facility dimensions are: capacity of 2.9 million yd^3 (2.2 million m^3); maximum height of approximately 65 feet (ft) (20 m); and an estimated area coverage of 80 acres (32 hectares) of the northeastern area of the Fernald site. At the end of 2005, approximately 2.75 million in-place yd^3 (2.10 million m^3) of waste were placed in the on-site disposal facility, of which in 2005 approximately 905,000 in-place yd^3 (691,963 m^3) of waste (including excavated material, debris, etc.) were placed in Cells 5, 6, 7, and 8 of the on-site disposal facility. Cells 1 through 6 were 100 percent full and capped as of the end of the year. Cell 7 was nearly filled to its capacity (94 percent) and the final cover system construction was in progress at the end of the year. Cell 8 reached approximately 63 percent of its capacity at the end of the year.

Figure 3-11 identifies the on-site disposal facility footprint and monitoring well locations for Cells 1 through 8. For additional information on the groundwater leak detection and leachate sampling results for the on-site disposal facility, refer to Appendix A, Attachment A.5.

TABLE 3-3
ON-SITE DISPOSAL FACILITY GROUNDWATER, LEACHATE, AND LEAK DETECTION SYSTEM MONITORING SUMMARY

Cell (Waste Placement Start Date)	Monitoring Location	Monitoring Zone	Date Sampling Started	Total Number of Samples	Range of Total Uranium Concentrations[a] (µg/L)
Cell 1	12338C	Leachate Collection System	February 17, 1998	37	ND – 142.186
(December 1997)	12338D	Leak Detection System	February 18, 1998	32	1.5 – 23.2
	12338	Glacial Till	October 30, 1997	57	ND – 19
	22201	Great Miami Aquifer	March 31, 1997	60	ND – 8.33
	22198	Great Miami Aquifer	March 31, 1997	86	0.513 – 15.2
Cell 2	12339C	Leachate Collection System	November 23, 1998	31	4.51 – 80.8
(November 1998)	12339D	Leak Detection System	December 14, 1998	32	8.69 – 22.3[b]
	12339	Glacial Till	June 29, 1998	54	ND – 8.16
	22200	Great Miami Aquifer	June 30, 1997	50	ND – 1.11
	22199	Great Miami Aquifer	June 25, 1997	57	ND– 12.1
Cell 3	12340C	Leachate Collection System	October 13, 1999	26	9.27 – 83.7
(October 1999)	12340D	Leak Detection System	August 26, 2002	13	13.3 – 27.7[b]
	12340	Glacial Till	July 28, 1998	52	ND – 29.3
	22203	Great Miami Aquifer	August 24, 1998	49	ND – 7.92
	22204	Great Miami Aquifer	August 24, 1998	54	ND – 14.3
Cell 4	12341C	Leachate Collection System	November 4, 2002	12	4.41 – 165
(November 2002)	12341D	Leak Detection System	November 4, 2002	13	5.45 – 16.4
	12341	Glacial Till	February 26, 2002	25	4.89 – 7.91
	22206	Great Miami Aquifer	November 6, 2001	32	ND – 5.78
	22205	Great Miami Aquifer	November 5, 2001	42	0.446 – 19.7
Cell 5	12342C	Leachate Collection System	November 4, 2002	15	3.39 – 211
(November 2002)	12342D	Leak Detection System	November 4, 2002	11	2.93 – 24.4
	12342	Glacial Till	February 26, 2002	25	7.45 – 21.1
	22207	Great Miami Aquifer	November 6, 2001	33	ND – 4.48
	22208	Great Miami Aquifer	November 5, 2001	40	ND – 2.1
Cell 6	12343C	Leachate Collection System	October 27, 2003	11	7.95 – 197
(November 2003)	12343D	Leak Detection System	October 27, 2003	9	3.1 – 29.5
	12343	Glacial Till	March 14, 2003	21	ND – 10.9
	22209	Great Miami Aquifer	December 16, 2002	30	ND – 2.38
	22210	Great Miami Aquifer	December 16, 2002	27	ND – 1.02
Cell 7	12344C	Leachate Collection System	September 2, 2004	7	4.65 – 202
(September 2004)	12344D	Leak Detection System	September 2, 2004	5	12.2 – 33.7
	12344	Glacial Till	February 24, 2004	15	0.674 – 3.91
	22212	Great Miami Aquifer	January 21, 2004	18	ND – 4.46
	22211	Great Miami Aquifer	January 21, 2004	19	ND – 3.21
Cell 8	12345C	Leachate Collection System	October 18, 2004	5	1.51 – 1.51
(December 2004)	12345D	Leak Detection System	October 18, 2004	5	0.888 – 9.38
	12345	Glacial Till	May 19, 2004	9	3.48 – 5.54
	22213	Great Miami Aquifer	March 31, 2004	16	ND – 0.374
	22214	Great Miami Aquifer	March 31, 2004	16	ND – 1.3
	22215	Great Miami Aquifer	August 22, 2005	3	ND – 0.625
	22216	Great Miami Aquifer	August 22, 2005	3	ND – 0.89

[a]ND = not detectable
[b]Some data not considered representative of true leak detection system uranium concentrations in Cell 2 (December 14, 1998 through May 23, 2000 data set) due to malfunction in the Cell 2 leachate pipeline and the resulting mixing of individual flows. Additionally, it is suspected that some November 2004 samples (i.e., 12339C and 12339D, 12340C and 12340D) were switched. If data from these events were included above, the maximum total uranium concentrations would be 71 µg/L for 12339D and 72.4 µg/L for 12340D.

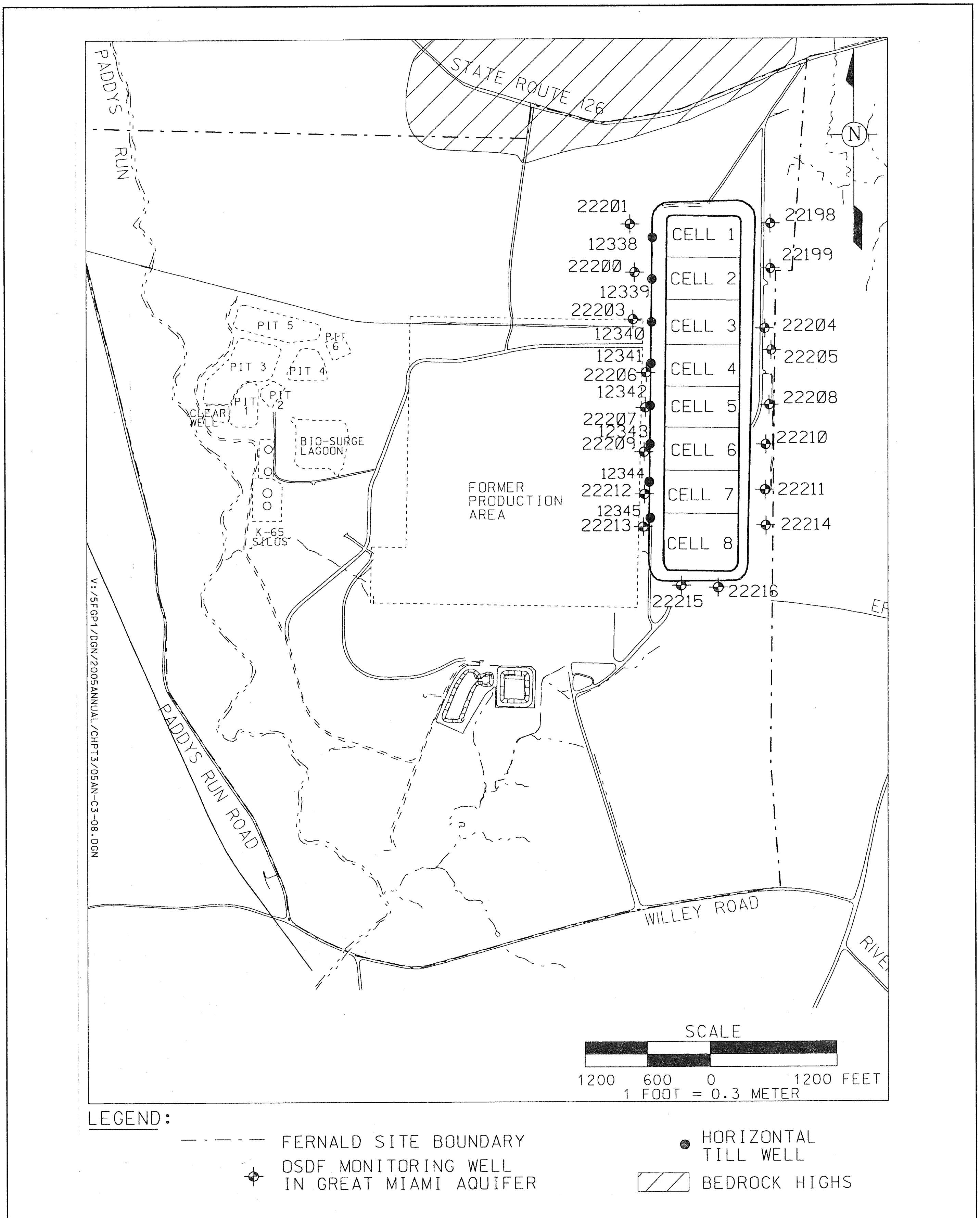

Figure 3-11. On-site Disposal Facility Footprint and Monitoring Well Locations